



DEEP LEARNING TEXT RECOGNITION AND EXTRACTION ON FORMATTED BILLS

Geetha M

Department of Computer Science and Engineering, Rajalakshmi Institute of Technology, Chennai, India
geetha.m@ritchennai.edu.in

Pooja R C, Swetha J, Nivedha N

Department of Computer Science and Engineering, Rajalakshmi Institute of Technology, Chennai, India

Abstract

Image processing, including the processing of invoices and handwritten bills, has become indispensable in all areas of business today. The main drawback is having to manually retype the material from invoices. As a result, extracting text from photos in their natural settings remains a formidable challenge. This study provides an in-depth look at text recognition for the purposes of extracting data from commonly used bill and invoice formats, such as handwritten notes and printed documents, for the purpose of automating database updates. The method developed in this study provides a quick and reliable means of extracting text from the bill. In this study, we will combine deep learning with Optical Character Recognition to analyse text in images and scanned documents and convert it into machine-readable text. After that, we use OpenCV to pull the text from the image, and then run it through our algorithm to ensure the highest level of accuracy possible before automatically saving the new text to our database.

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Introduction

Image processing, including the processing of invoices and handwritten bills, has become indispensable in all areas of business today. Since doing so would be a waste of time, we can't enter the information manually into a specific format [5]. Although the conventional method involved extracting text from photos, it also uncovered a number of related issues [6]. Having spent some effort on extraction, I can attest to the difficulty of accurately transforming an image to text [7]. They play a crucial role in the exchange of textual information between human and computer [8-12]. In order to get text out of photos, this study employs OpenCV and Nanonet. Recognizing text in natural photographs remains a difficult task [13]. This study

provides an in-depth look at text recognition for the purposes of extracting data from commonly used bill and invoice formats, such as handwritten notes and printed documents, for the purpose of automating database updates [14-17]. The method developed in this study provides a quick and reliable means of extracting text from the bill. In this paper, we'll discuss how to incorporate deep learning into text detection and extraction by first using optical character recognition to convert human-unreadable text from an image or scanned document into machine-readable form, then using Open CV to extract the text from the image, and finally using our algorithm to get the most accurate results possible so that the text can be added to the database in an automated fashion [18]. Because there is no need for human labour, problems like incorrect data entry can be avoided [19]. Information extracted from scanned documents is thus highly accurate. One of the most significant advantages of OCR data entry methods is that it allows organisations to cut down on the number of people they need to hire to perform data extraction [20]. Obtaining the highest possible degree of precision in retrieving search results is also achieved [21-24].

In recent years, deep learning has garnered an incredible amount of attention. The most common and well-respected kind of images [25]. CNNs have found widespread use in fields such as object detection and facial recognition. Image classifications using CNNs begin with an input image, process it, and then assign it to one of many predetermined categories (Eg ., Dog, Cat, Tiger, Lion) [26]. A computer interprets a picture as a grid of pixels, the exact number of which is dependent on the image's resolution. Depending on the image's pixel dimensions (h = height, w = width, d = dimension), it will interpret these values as $h \times w \times d$. Examples include a matrix picture with dimensions of 6 by 6 by 3 with RGB values indicated by the number 3 and a matrix image with dimensions of 4 by 4 by 1 with grayscale values indicated by the number 1. To identify an item with probabilistic values between 0 and 1, deep learning CNN models train and test each input image by running it through a sequence of convolution layers with filters (Kernels), Pooling layers, and fully connected layers (FC), and then applying the Softmax function [27-34].

A Precise and Effective Setting the Text Detector approach uses deep learning to reliably identify text. In fact, it's the only known method for detecting text, therefore it deserves special attention [35]. It is also compatible with any other text recognition technique [36]. In order to reduce the number of unnecessary steps, this paper's text detection pipeline is broken down into only two distinct phases [37-42]. Specifically, one can use the fully convolutional network to generate word or text line-level prediction [43]. After the non-maximum suppression stage, the output is formed from the produced predictions, which are typically rotated rectangles or quadrangles. EAST is capable of identifying text in both still photos and moving footage. According to the paper's claims, it can recognise text in 720p images at 13 frames per second while maintaining a high level of accuracy [44]. Furthermore, this method is already implemented in OpenCV 3.4.2 and OpenCV 4, which is a huge plus. This EAST model will be demonstrated alongside text recognition [45-49].

The EAST algorithm makes predictions at the word or line level using a single neural network. It is able to recognise text in any direction by looking for quadrilateral shapes [50]. As of 2017, this algorithm performed better than the best available approaches. The core of this approach is a fully-convolutional network that merges using non-max suppression (NMS) [51]. In order to pinpoint text in an image, a fully convolutional network is employed; this NMS stage then unifies the several text boxes recognised by the network into a single bounding box for each text location (word or line text) [52-55]. The EAST framework was developed with the varying sizes of the world's regions in mind [56]. The goal was to identify large word regions using features from the final stage of the neural network, while identifying small regions using features from the first stage [57]. Rather than using a single neural network, the scientists have integrated three different neural networks into one [58].

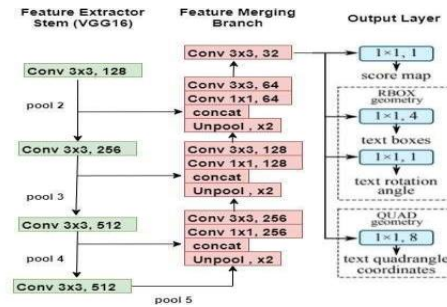


Figure 1: EAST framework [1]

Feature extractor stem:

This section of the network gathers information from several different nodes. The presented item may be a convolutional network that has already been trained using the ImageNet dataset [59]. The authors of the EAST framework conducted their experiment using both PVANet and VGG16. Only the EAST configuration of the VGG16 network will be shown in this weblog [60-63]. Let's take a look inside the VGG16 model and see how it's put together [64].

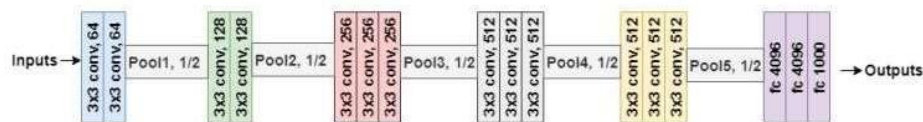


Figure 2: VGG16 [2]

This section of the network gathers information from several different nodes [65]. The presented item may be a convolutional network that has already been trained using the ImageNet dataset. The authors of the EAST framework conducted their experiment using both PVANet and VGG16 [66]. Only the EAST configuration of the VGG16 network will be shown in this weblog [67-71]. Let's take a look inside the VGG16 model and see how it's put together. A score map plus a geometry map make up the output layer. The chance of finding text in a given area is represented by the score map, while the text box itself is delineated by the geometry map [72]. It's up to the user to decide whether this geometry map is a box or a square with a rotation. We can define a rotated box with its top-left coordinate, width, height, and rotation angle. A quadrangle, on the other hand, includes all four corners of a rectangle [73-81].

Loss Function

This EAST technique employs a loss function that combines a score map loss with a geometry loss function [82].

$$L = L_s + \lambda_g L_g$$

According to the aforementioned calculation, both losses are aggregated using a weight of. Use this symbol to quantify the severity of various forms of financial setback [83-85]. A number of authors in the EAST paper have interpreted this as 1. Phase of Convergent Suppression Below Maximum Geometries predicted by a fully convolutional network that have been subjected to a threshold. An NMS that takes local context into account is then used to suppress any remaining geometries. Nave NMS is implemented in O. (n²) [86]. Although this can be executed in O(n), the authors chose for an approach that employs row-by-row suppression to achieve that time limit. The last merged row is taken into account as part of this row-by-row suppression process [87]. The worst-case time complexity of this method is still O, despite the fact that it is fast in most situations (n²) [88].

Recurrent Neural Network

Short for "Recurrent Neural Network," RNNs are a special kind of neural network that finds extensive application in NLP [89]. Assuming that two successive inputs are independent, a generic neural network processes an input through some layers and generates an output. However, in some real-world situations, this

assumption proves to be false [90]. For example, while trying to forecast the stock price at a specific moment or the next word in a series, one must take into account the importance of prior data [91-93]. The output of an RNN is dependent on the results of earlier calculations, hence the name "recurrent." This is because the RNN performs the same task for each sequence member. Alternatively, RNNs can be thought of as having a "memory" that stores data about previous calculations. While RNNs have the potential to utilise data from infinitely lengthy sequences, in practise they can only retrace their steps a small number of times [94]. The RNN version LSTM, which can look back further than the original RNN, has proven to be quite effective in the field of natural language processing. People's minds don't reset themselves every single second. The words in this essay build upon one another as you read them. You don't just toss everything out and start over. It's clear that your thoughts are tenacious. This is a key limitation of conventional neural networks [95-101]. Let's say, for argument's sake, you're interested in labelling every scene in a film according to the type of event occurring there. It's not apparent how a classic neural network would be able to reason about what happened before in the movie and apply that knowledge to the present. This problem is solved by recurrent neural networks. They are recursive networks where data can be stored indefinitely [102].

The recurrent neural network has loops

The node AA in the above diagram receives the input x_t and returns the result h_t . A network's ability to transfer data from one stage to the next is greatly facilitated by the inclusion of a loop. These iterative processes provide a mysterious air to recurrent neural networks [103-104]. But if you give it some more thought, you'll realise they're not so different from a regular neural network. One way to conceptualise a recurrent neural network is as a collection of identical networks that each communicate with their successors [105]. This chainlike structure demonstrates that recurrent neural networks are closely linked to sequences and lists. They are the most intuitive neural network architecture for this kind of information [106]. And they are put to good use. Speech recognition, language modelling, translation, and image captioning are just a few examples of areas where RNNs have been applied with great success in recent years. These achievements owe a great deal to the deployment of "LSTMs," a subset of recurrent neural networks that excels where the classic form fails [107-112]. Almost all of the fascinating outcomes of recurrent neural networks are accomplished by using them. This paper will focus on these long short-term memories [113].

LSTM Networks

LSTMs, short for long short-term memory networks, are a subclass of RNNs that can learn complex dependencies over time. Hochreiter and Schmidhuber (1997) introduced them, and many others have since improved upon and made them more widely used. 1 They're extensively employed since they're effective across a wide range of issues. To circumvent this issue, LSTMs are built to be independent for as long as possible [114-119]. They don't have to work hard to remember things for extended periods of time; it's just how they naturally behave. It's possible to think of a recurrent neural network as a series of smaller neural networks connected together [120]. This recurrent module in conventional RNNs will typically consist of a single tanh layer, among other things [121].

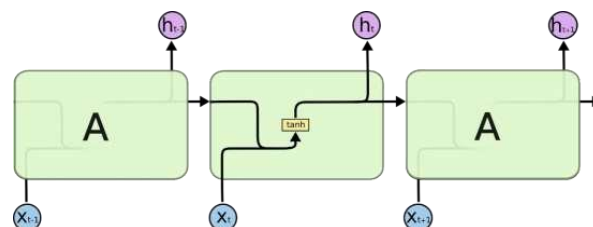


Figure 3: The repeating module in a standard RNN contains a single layer [3]

Similarly, LSTMs have this chain structure, but the repeating module is organised differently. An unusual four-layer neural network structure is used instead of a single layer (fig.4).

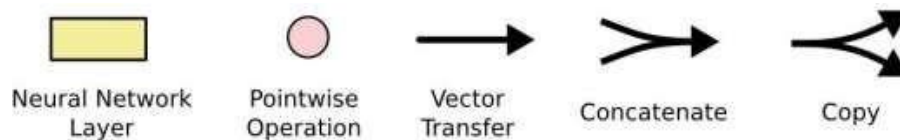


Figure 4: The repeating module in an LSTM contains four interacting layers [4]

Each line in the preceding diagram conveys a complete vector from the output of one node to the inputs of the next nodes [122-125]. Point-wise operations like vector addition are depicted by the pink circles, and the yellow boxes represent learnt layers in a neural network [126-131]. When two lines come together, they are said to be concatenating, but when one line splits into two, it is said to be forking. The horizontal line at the top of the diagram represents the cell state, which is the most important part of LSTMs [132]. The cellular state can be compared to a moving conveyor belt. It descends the entire chain in a straight line with little linear interactions [133]. Any data can simply be transmitted along it without any modification. By using structures called gates, the LSTM can selectively delete or add information to the cell state. For selectively allowing data to pass through, we have gates [134]. A sigmoid network layer and a point-wise multiplication operation are the constituent parts [135]. The sigmoid layer provides a range of values between 0 and 1 that indicate the level of passthrough for each component. If the value is zero, then nothing is allowed through, and if it's one, then everything is. The cellular state in an LSTM is guarded and regulated by three gates. Long short-term memories (LSTMs) were a major advancement in RNN capabilities [136-141]. The objective is to have the RNN decide at each stage what data to examine from a larger pool. For every word it generates in an image caption, for instance, an RNN may consider a different region of the image. Using attention has yielded some promising outcomes, and there appears to be much more on the horizon [142].

Literature Survey

New approaches to text extraction yield better outcomes. The literature contains numerous publications that have already investigated this general concept, providing a solid foundation for our own. The extraction procedure has been greatly improved because to the contributions of numerous scholarly works [143-149]. A domain-independent optical character recognition (OCR) tool and a knowledge-based information extraction component (FRESCO) make up the system. With an error rate of less than 1 percent for the items to be retrieved, the automation rate for analysing health insurance bills is well above 50 percent [150].

System, method, and computer programme product for obtaining data from a telecommunications invoice were presented by JA Devolites, R Cybyk, and J Wyatt in 2010. To model the telecommunications invoice data stream and map it to a normalised data format, one embodiment of the present invention involves receiving a telecommunications invoice data stream in a first data format, analysing the telecommunications invoice data stream to determine the first data format, and so on. For example, in one implementation, the method may involve: where the modelling of the telecommunications invoice data stream may further involve any of creating a model for the first data format; modelling the telecommunications invoice data stream according to the model; and/or modelling the telecommunications invoice data stream with an intelligent adapter [151].

In this study, we introduced an approach to finding useful information in semi-structured papers. Instead of using predefined templates, rules, or optical character recognition (OCR)-based engines, this approach analyses the morphological composition of documents and the structural link between columns and text rows in order to accurately capture their contents. Structured clustering is a two-stage process that analyses the document's columns and then clusters rows of text that are comparable together [152-155]. The next step is a mechanism that refines the output and combines together not individual text rows but rather groupings of text rows [156]. Extra care is taken to properly associate these text rows, as we do not permit group splitting in the usual bottom-up method. The method was then put to the test across numerous document categories, with encouraging results: a 95.53 percent accuracy rate on the test set. The following phase involved feeding the results from the geometric layout analysis into a logical layout analysis to give each of the classes discovered in the geometric analysis a logical interpretation. The approach uses a set of (positive) sample entities that are taken from either enterprise databases (such as a product catalogue) or annotated documents (e.g., historical invoices) [157]. Our key invention is a method for learning powerful regular expressions that

are also easy to understand and use [158]. The efficiency comes from a novel approach that compares and contrasts dependent entity properties at several levels of granularity (i.e., character and token level) and chooses the most appropriate ones to build a regular expression [159].

Form processing is now invented. It extracts non-personalized data from filled forms. As such, in accordance with some embodiments of the present invention, a form processing method is provided for extracting data items from a form that has been digitised in the form of a digital image, the method comprising: prompting a user to indicate a location of one or more physical fields, each physical field relating to a data item of a specific type; receiving one or more indications provided by the user regarding the location of the physical fields; identifying Some preferred implementations of the present invention also include detecting the locations of said one or more physical fields and using them to create a template with instructions on where to find data items of the same type on forms with a similar layout. The procedure may also entail comparing another digital image of a different form to the template and automatically extracting data items using the template instructions. In certain implementations, a single click of a pointing device on or near the data item in the image indicates the user's physical field location.

In other embodiments of the present invention, the user taps the image's touch screen or near the data item to indicate the physical field's location. PA "VanZyl" (2015) Because it saves time and effort, the proposed automatic extraction and handling of invoice document information could benefit many firms. Document Analysis and Recognition (DAR) uses OCR to analyse and recognise physical documents to digitally extract and process their content. It includes preprocessing, layout analysis, text recognition, and post-processing. Pre-processing prepares document images for later processing. Any errors not discovered during pre-processing will propagate through the rest of the OCR process, resulting in erroneous recognition. Identifying the best effective pre-processing methods for invoice document analysis and recognition will benefit relevant academic fields and commercial communities. To solve the problem, exploratory study was done. Case studies examined five DAR-related business owners and CEOs. Transcribed semi-structured interviews were analysed for recurring themes. Second investigation was experimental. The research used invoice document images and a range of pre-processing approaches to evaluate their effectiveness at improving recognition rates. The recognition rates of different tactics allowed for quantitative examination. DAR companies use the same business model, as discovered. This lengthy study examined industry-standard DAR software, ICR methods, and scanning techniques. The widening gap between paper-based information and computer processing ensures the industry's future.

It was effectively demonstrated that some pre-processing procedures work better than others. Results from the tests also revealed a wealth of information about the efficacy of various methods. Techniques could be compared with respect to their processing times. Time to process could refer either to the time needed to apply the technique to the document image, or the time needed to recognise the text in the processed document image. A computer-readable storage medium is any device or medium that may store code and/or data for use by a computer system, such as the data structures and code described in this system. There are many different types of computer-readable storage media, such as magnetic and optical discs, tapes, and even paper documents that can be stored in a drawer or a filing cabinet. Disk drives, magnetic tape, CDs, DVDs, or any other media capable of storing code and/or data, whether now existing or produced in the future.

Form data extraction, such as that found on bills, is the focus of this disclosure. An illustrative approach refers to a particular data type as a Label: value, with the label component equivalent to a text string expressing a data label connected with its value component. Although the present thorough discussion is directed toward specific embodiments, such as the extraction of information from forms, it is to be appreciated that the disclosed technique and methods of extracting information applicable to documents, including a tabular arrangement in general. At the outset, information is culled from an image or native digital document to determine what can be used for textual and graphical purposes. Next, candidates for layout structures are produced utilising text and graphical elements related to the input document, with the understanding that a given element may belong to many layout structures. The information labels are then

used to tag relevant content. For information to be usable with the disclosed method and system, it must have the same label:value structure. Targeted information is a collection of pieces of data that need to be extracted so that a best-match assignment may be made between those pieces of data and the label:value pairs that have been extracted. Invoice data processing is a subfield of data extraction in which relevant information is culled from scanned invoices. Current methods often use templates to help collect certain data. Due to the extensive template requirements, however, this method has limited applicability.

Proposed Work

Fig. 1 shows an offline HTR system that digitises handwritten text from pictures. We want to train an IAM dataset-based Neural Network (NN) to recognise word pictures. Since the input layer and subsequent layers may be kept low, CPU NN training is possible for word images (of course, a GPU would be better). This solution provides the TF-HTR minimal functionality. NNs are used for this. The design includes convolutional, recurrent, and Connectionist Temporal Classification (CTC) layers. The NN may alternatively be viewed formally as a function (see Eq. 1) that converts an image (or matrix) M of size WH to a character sequence (c_1, c_2, \dots) of length 0 to L . Character-by-character analysis reveals that not just words and texts from the training data but also those not included there can be identified (as long as the individual characters get correctly classified). For this purpose, we employ the utilisation of a NN. Layers of convolutional NNs (CNNs), recurrent NNs (RNNs), and a Connectionist Temporal Classification (CTC) layer round out the architecture. The architecture of our HTR system is depicted in Fig. 2. In a more mathematical sense, we may think of the NN as a function (see Eq. 1) that converts an image (or matrix) M of size WH to a character sequence (c_1, c_2, \dots) of length 0 to L . As can be seen, the text is understood at the level of individual characters. Accordingly, recognition is not limited to data included in the training set (as long as the individual characters get correctly classified).

$$\text{NN: } M \rightarrow (c_1, c_2, \dots, c_n)$$

$W \times H \qquad 0 \leq n \leq L$

Result and Discussion

We've covered a NN that can read text from photos. The NN has 5 CNN layers and 2 RNN layers, and it produces a character-probability matrix as an output (fig.6).



Figure 6: Out put

Depending on the situation, this matrix is substituted for the CTC loss computation or the CTC decoding. Important pieces of the code for a TF implementation are shown. Finally, suggestions were made to enhance the precision of the recognition.

Conclusion

A text recognizer scans and updates the database fields of manually entered bills and invoices, detecting and recognising characters as they are written. The process of automatically digitising printed and handwritten text from an image for the purposes of adding it to a database. We begin by scanning a bill and extracting the text using OCR with deep learning, where text detection is performed in EAST in CNN; next, recognition is implemented by RNN and the extracted text is compared to the trained dataset using the IAM dataset; if it is

recognised, the database is updated. Python's OpenCV packages were used to create the system for extracting text from bills and invoices. OpenCV and Nanonet OCR were both updated to their most recent versions. Effectively detect the banknotes using pre-processing, a segmentation method, and text extraction. IAM is used to analyse the data set and the database is updated automatically. To capture the photograph and continue the process, we are designing the android studio for usage in a mobile phone.

References:

1. J. Benabderrazak, "OpenCV EAST model and Tesseract for detection and recognition of text in natural scenes," Medium, 05-Apr-2020. [Online]. Available: <https://jaafarbenabderrazak-info.medium.com/opencv-east-model-and-tesseract-for-detection-and-recognition-of-text-in-natural-scene-1fa48335c4d1>. [Accessed: 01-Feb-2023].
2. "Efficient and accurate scene text detector (EAST)," TheAILearner, 19-Oct-2019. [Online]. Available: <https://theailearner.com/2019/10/19/efficient-and-accurate-scene-text-detector-east/>. [Accessed: 01-Feb-2023].
3. "Interpretation of RNN/LSTM cell," Stack Overflow. [Online]. Available: <https://stackoverflow.com/questions/61399871/interpretation-of-rnn-lstm-cell>. [Accessed: 01-Feb-2023].
4. Y. Verma, "Complete guide to Bidirectional LSTM (with python codes)," Analytics India Magazine, 17-Jul-2021. [Online]. Available: <https://analyticsindiamag.com/complete-guide-to-bidirectional-lstm-with-python-codes/>. [Accessed: 01-Feb-2023].
5. Haq, M. A. Development of PCCNN-Based Network Intrusion Detection System for EDGE Computing. Comput. Mater. Contin. 71, 1729–1750 (2021).
6. Haq, M. A. Machine Learning-based Classification of Hyperspectral Imagery. Int. J. Comput. Sci. Netw. Secur. 22, 1–10 (2022).
7. Amit Kumar Jain, "Overview of Serverless Architecture," International Journal of Engineering Research & Technology, vol. 11, no. 09, p. 3, 2022.
8. Amit Kumar Jain, "Multi-Cloud Computing & Why do we need to Embrace it," International Journal Of Engineering Research & Technology, vol. 11, no. 09, p. 1, 2022.
9. Amit Kumar Jain, "Hybrid Cloud Computing: A Perspective," International Journal of Engineering Research & Technology, vol. 11, no. 10, p. 1, 2022.
10. Haq, M. A. & Ahmed, A. On Interesting Correlation between Meteorological Parameters and COVID-19 Pandemic in Saudi Arabia. Int. J. Comput. Sci. Netw. Secur. 22, 1–10 (2022).
11. Haq, M. A. Planetscope Nanosatellites Image Classification Using Machine Learning. Comput. Syst. Sci. Eng. 42, 1031–1046 (2022).
12. Ananda Shankar Hati, and T. K. Chatterjee, "Symmetrical component filter based online condition monitoring instrumentation system for mine winder motor" Measurement (Elsevier), vol. 82, pp. 284-300, 2016 <https://doi.org/10.1016/j.measurement.2016.01.005>
13. Prashant Kumar and Ananda Shankar Hati "Review on Machine Learning Algorithm Based Fault Detection in Induction Motors," Archives of Computational Methods in Engineering, vol: 28, pp: 1929-1940, 2021 <https://doi.org/10.1007/s11831-020-09446-w>.
14. Kumar Prashant and Hati, Ananda Shankar "Convolutional Neural Network with batch normalization for fault detection in SCIM," IET Electric Power Application, vol: 15, issue: 1, pp. 39-50, 2021.
15. Kumar Prashant and Hati, Ananda Shankar "Deep Convolutional Neural Network based on adaptive gradient optimizer for fault detection in SCIM," ISA Transactions, vol: 111, pp: 350-359, 2021 <https://doi.org/10.1016/j.isatra.2020.10.052>.
16. Prince, Hati Ananda Shankar, Chakrabarti Prasun, Abawajy Jemal Hussein and Ng Wee Keong

- "Development of Energy Efficient Drive for Ventilation System using Recurrent Neural Network," Neural Computing and Applications, Vol. 33, no. 14, pp. 8659-8668, 2021 <https://doi.org/10.1007/s00521-020-05615-x> <https://doi.org/10.1007/s00521-020-05615-x>.
17. Sinha Ashish Kumar, Hati Ananda Shankar, Benbouzid Mohamed and Chakrabarti Prasun "ANN-based Pattern Recognition for Induction Motor Broken Rotor Bar Monitoring under Supply Frequency Regulation" Machines (2021), vol: 9(5) <https://doi.org/10.3390/machines9050087>.
 18. Prince and Hati Ananda Shankar "A Comprehensive Review of Energy-Efficiency of Ventilation System using Artificial Intelligence" Renewable and Sustainable Energy Reviews (2021), vol: 146, 2021 <https://doi.org/10.1016/j.rser.2021-.111153>.
 19. Kumar Prashant and Hati, Ananda Shankar "Transfer Learning Based Deep CNN Model for Multiple Faults Detection in SCIM" Neural Computing and Applications (2021) <https://doi.org/10.1007/s00521-021-06205-1>.
 20. Prince and Hati Ananda Shankar "Temperature and Humidity Dependent MRAS Based Speed Estimation Technique for Induction Motor used in Mine Ventilation Drive" Journal of Mining Science, 2021, Vol. 57, No. 5, pp. 842–851., <https://doi.org/10.1134/S1062739121050148>.
 21. Kumar Prashant and Hati, Ananda Shankar "Dilated Convolutional Neural Network Based Model For Bearing Faults and Broken Rotor Bar Detection in Squirrel Cage Induction Motors" Expert Systems With Applications (2022) <https://doi.org/10.1016/j.eswa.2021.116290>.
 22. Prince and Hati Ananda Shankar "Convolutional Neural Network-Long Short Term Memory Optimization for Accurate Prediction of Airflow in a Ventilation System" Expert Systems with Applications (2022) <https://doi.org/10.1016/j.eswa.2022.116618>.
 23. Vatsa Aniket and Hati Ananda Shankar "Depolarization Current Prediction of Transformers OPI System Affected From Detrapped Charge Using LSTM," in IEEE Transactions on Instrumentation and Measurement, vol. 71, pp. 1-11, 2022, Art no. 2511711.
 24. Gorai Rahul, Hati Ananda Shankar, and Maity Tanmoy, "A new cascaded multilevel converter topology with a reduced number of components" 3rd IEEE 2017 Conference on International conference on Power, Control, Signals and Instrumentation Engineering (ICPCSI-2017), 21-22 September 2017 | IEEE, Chennai, India., pp. 539-543, DOI: 10.1109/ICPCSI.2017.8392351.
 25. Kumar Prashant, Hati, Ananda Shankar, Sanjeevikumar Padmanaban, Leonowicz Zbigniew and Prasun Chakrabarti "Amalgamation of Transfer Learning and Deep Convolutional Neural Network for Multiple Fault Detection in SCIM" 2020 IEEE International Conference on Environment and Electrical Engineering and 2020 IEEE Industrial and Commercial Power Systems Europe (EEEIC/I&CPS Europe), 9th-12th June 2020, Madrid, Spain.
 26. Sinha Ashish Kumar, Kumar Prashant, Prince and Hati, Ananda Shankar, "ANN Based Fault Detection Scheme for Bearing Condition Monitoring in SRIMs using FFT, DWT and Band-pass Filters" 2020 International Conference on Power, Instrumentation, Control, and Computing (PICC) 2020 IEEE | DOI: 10.1109/PICC51425.2020.9362486.
 27. Prince Kumar and Hati, Ananda Shankar, "Sensor-less Speed Control of Ventilation System Using Extended Kalman Filter For High Performance," 2021 IEEE 8th Uttar Pradesh Section International Conference on Electrical, Electronics and Computer Engineering (UPCON), 2021, pp. 1-6, DOI: 10.1109/UPCON52273.2021.9667633
 28. Kumar Prashant and Hati, Ananda Shankar "Support Vector Classifiers based broken rotor bar detection in Squirrel cage induction motor" Machines, Mechanisms and Robotics, Springer, Singapore, 429-438 DOI: 10.1007/978-981-16-0550-5
 29. Hati, Ananda Shankar, and Chatterjee, T. K., "Some studies on condition monitoring techniques for online condition monitoring and fault diagnosis of mine winder motor", International Journal of

- Engineering Science and Technology (IJEST), vol. 4, no. 08, pp. 3785-3793, August 2012.
30. Hati, Ananda Shankar, and Chatterjee, T. K., "Axial leakage flux-based online condition monitoring instrumentation system for mine winder motor" *Journal of Mines, Metals & Fuels*, vol. 63, no. 5&6, pp. 132-140, May-June 2015.
 31. Hati, Ananda Shankar, and Chatterjee, T. K., "Current monitoring Instrumentation system for detecting airgap eccentricity in mine winder motor", *International Journal of Applied Engineering Research*, vol. 10, no. 22, pp. 43000-43007, 2015.
 32. Hati, Ananda Shankar, "Vibration monitoring instrumentation system for detecting airgap eccentricity in mine winder motor" *Journal of Mine Metals and Fuels*, vol. 64, no. 5&6, pp. 240-248, May-June 2016.
 33. Haq, M. A., Baral, P., Yaragal, S. & Pradhan, B. Bulk processing of multi-temporal modis data, statistical analyses and machine learning algorithms to understand climate variables in the indian himalayan region. *Sensors* 21, (2021).
 34. Haq, M. A. Deep Learning Based Modeling of Groundwater Storage Change. *Comput. Mater. Contin.* 70, 4599–4617 (2021).
 35. H. Nayak, A. Kushwaha, P.C. Behera, N.C. Shahi, K.P.S. Kushwaha, A. Kumar and K.K. Mishra, "The pink oyster mushroom, *Pleurotus djamor* (Agaricomycetes): A potent antioxidant and hypoglycemic agent," *International Journal of Medicinal Mushrooms*, vol. 23, no. 12, p. 29-36, 2021.
 36. Haq, M. A., Jain, K. & Menon, K. P. R. Modelling of Gangotri glacier thickness and volume using an artificial neural network. *Int. J. Remote Sens.* 35, 6035–6042 (2014).
 37. Haq, M. A., Baral, P., Yaragal, S. & Rahaman, G. Assessment of trends of land surface vegetation distribution, snow cover and temperature over entire Himachal Pradesh using MODIS datasets. *Nat. Resour. Model.* 33, (2020).
 38. O. M. Abo-Seida, N. T. M. El-dabe, A. Refaie Ali and G. A. Shalaby, "Cherenkov FEL Reaction with Plasma-Filled Cylindrical Waveguide in Fractional D-Dimensional Space" *IEEE Transactions on Plasma Science*, vol. 49, no. 7, pp. 2070-2079, July 2021.
 39. Nabil T. M. El-dabe, A. Refaie Ali, A. A. El-shekipy, and G. A. Shalaby, "Non-Linear Heat and Mass Transfer of Second Grade Fluid Flow with Hall Currents and Thermophoresis Effects", *Applied Mathematics & Information Sciences (AMIS)*, vol. 11, no. 1, pp. 267-280, 2017.
 40. N.T.M.El-Dabe, A.Refaie Ali, and A.A.El-shekipy, "Influence of Thermophoresis on Unsteady MHD Flow of Radiation Absorbing Kuvshinski Fluid with Non-Linear Heat and Mass Transfer", *Columbia International Publishing American Journal of Heat and Mass Transfer* 2017. <https://www.sciencegate.app/app/redirect#aHR0cHM6Ly9keC5kb2kub3JnLzEwLjc3MjYvYWpobXQuMjAxNy4xMDEw>
 41. Sunil Devidas Bobade, Nita S. patil , Sanjay M. Patil , Ajay Reddy Yeruva , Parth M. Pandya5 , Ahmed Refaie Ali, "Efficient Deterministic Approach for Coverage Hole Detection In Wireless Sensor Underground Network: Mathematical And Stimulation Model", *Journal of Pharmaceutical Negative Results*, vo;.13, Special Issue9, 2022.
 42. Osama M. Abo-Seida , N.T.M.Eldabe , A.Refaie Ali , G. A. Shalaby, "Far-Field, Radiation Resistance and temperature of Hertzian Dipole Antenna in Lossless Medium with Momentum and Energy Flow in the Far- Zone", *Journal of Advances in Physics*, vol. 18 ISSN: pp. 2347-3487, 2020.
 43. Osama M. Abo-Seida, N.T.M.Eldabe, M. Abu-Shady, A.Refaie Ali, "Electromagnetic non-Darcy Forchheimer flow and heat transfer over a nonlinearly stretching sheet of non-Newtonian fluid in the presence of a non-uniform heat source", *Solid State Technology*, vol. 63, no. 6, 2020.
 44. Abo-Seida, Osama M., N. T. M. Eldabe, and Ahmed Refaie Ali. "Gamil. Ali Shalaby, " Far-Field, Radiation Resistance and temperature of Hertzian Dipole Antenna in Lossless Medium with Momentum

- and Energy Flow in the Far-Zone” Journal of Advances in Physics , vol. 18, pp 20-28, 2020.
45. Haq, M. A., Rahaman, G., Baral, P. & Ghosh, A. Deep Learning Based Supervised Image Classification Using UAV Images for Forest Areas Classification. J. Indian Soc. Remote Sensing. 49, 601–606 (2020).
 46. Baral, P. & Haq, M. A. Spatial prediction of permafrost occurrence in Sikkim Himalayas using logistic regression, random forests, support vector machines and neural networks. Geomorphology 371, 107331 (2020).
 47. SS Priscila, M Hemalatha, “Improving the performance of entropy ensembles of neural networks (EENNS) on classification of heart disease prediction”, Int J Pure Appl Math 117 (7), 371-386, 2017.
 48. S Silvia Priscila, M Hemalatha, “ Diagnosis of heart disease with particle bee-neural network” Biomedical Research, Special Issue, pp. S40-S46, 2018.
 49. S Silvia Priscila, M Hemalatha, “ Heart Disease Prediction Using Integer-Coded Genetic Algorithm (ICGA) Based Particle Clonal Neural Network (ICGA-PCNN)”, Bonfring International Journal of Industrial Engineering and Management Science 8 (2), 15-19, 2018.
 50. Tadiboina, S. N., & Kumar, S. (2019). Treatment Policies For Chronic Illnesses And The Potential To Transform Health Care With Artificial Intelligence. Ilkogretim Online, 18(1), 610-619.
 51. Ali-Mohammad Kamali , Milad Kazemiha, Behnam Keshtkarhesamabadi, Mohsan Daneshvari, Asadollah Zarifkar, Prasun Chakrabarti, Babak Kateb, Mohammad Nami “Simultaneous Transcranial and Transcutaneous Spinal Direct Current Stimulation to Enhance Athletic Performance Outcome in Experienced Boxers”, Scientific Reports , 11 : 19722, 2021.
 52. Xin Wang, Yuhao Zhou, Tingwen Huang, Prasun Chakrabarti , "Event-triggered Adaptive Fault-tolerant Control for a Class of Nonlinear Multiagent Systems with Sensor and Actuator Faults" , IEEE Transactions on Circuits and Systems I: Regular Papers, 2022.
 53. Tuan Pham Van, Dung Vo Tien, Zbigniew Leonowicz , Michal Jasiński , Tomasz Sikorski , Prasun Chakrabarti “Online Rotor And Stator Resistance Estimation Based On Artificial Neural Network Applied In Sensorless Induction Motor Drive”, Energies , 13 : 4946 , 2020.
 54. Imayanmosha Wahlang, Arnab Kumar Maji, Goutam Saha, Prasun Chakrabarti, Michał Jasiński , Zbigniew Leonowicz, Elzbieta Jasinska , “Deep Learning methods for classification of certain abnormalities in Echocardiography”, Electronics , 10 : 495., 2021.
 55. Rajkumar Soni , Prasun Chakrabarti , Zbigniew Leonowicz , Michal Jasinski , Krzysztof Wiecek , Vadim Bolshev, “Estimation of Life Cycle of Distribution Transformer in Context to Furan Content Formation , Pollution Index and Dielectric Strength”, IEEE Access, 9 : 37456, 2021.
 56. Yogendra Singh Solanki, Prasun Chakrabarti, Michal Jasinski , Zbigniew Leonowicz, Vadim Bolshev , Alexander Vinogradov, Elzbieta Jasinska, Radomir Gono, Mohammad Nami , “A Hybrid Supervised Machine Learning Classifier System for Breast Cancer Prognosis Using Feature Selection and Data Imbalance Handling Approaches”, Electronics ,10(6) : 699, 2021.
 57. Siddhartha Bhattacharyya, Tulika Dutta, Sandip Dey, Somnath Mukhopadhyay, Prasun Chakrabarti , “Hyperspectral Multi-level Image Thresholding using Quatrit Genetic Algorithm Expert Systems With Applications”, Expert Systems with Applications, 181 : 115107, 2021.
 58. Sergey Senkevich, Vadim Bolshev, Ekaterina Ilchenko, Prasun Chakrabarti, Michał Jasiński, Zbigniew Leonowicz , Mikhail Chaplygin, "Elastic Damping Mechanism Optimization by Indefinite Lagrange Multipliers", IEEE Access,9 :71784,2021.
 59. Tapan Behl, Anuja Singh ,Aayush Sehgal ,Sukhbir Singh , Neelam Sharma, Tanveer Naved, Saurabh Bhatia, Ahmed Al-Harrasi, Prasun Chakrabarti, Lotfi Aleya,Simona Bungau “Mechanistic Insights into the Role of B Cells in Rheumatoid Arthritis”, International Immunopharmacology, 99 : 108078 , 2021.

60. Zuhaib Ashfaq Khan, Hafiz Husnain Raza Sherazi , Mubashir Ali, Muhammad Ali Imran, Ikram Ur Rehman, Prasun Chakrabarti , “Designing Wind Energy Harvester for Connected Vehicles in Green Cities”, *Energies* , 14(17) :5408, 2021.
61. M A Berlin , N Upadhayaya, A Alghatani, V Tirth, S Islam, K Murali, P R Kshirsagar, Bui Thanh Hung, Prasun Chakrabarti , Pankaj Dadheech , “Novel hybrid artificial intelligence based algorithm to determine the effects of air pollution on human electroencephalogram signals”, *Journal of Environmental Protection and Ecology* , 22(5): 1825-1835,2021.
62. M Abul Hasan, K Raghuveer, P S Pandey, Ashok Kumar, Ashim Bora, Deepa Jose, P R Kshirsagar, Bui Thanh Hung, Prasun Chakrabarti , M M Khanapurkar , “Internet of Things and its applications in Industry 4.0 for Smart Waste Management”, *Journal of Environmental Protection and Ecology* , 22(6): 2368-2378,2021.
63. Vivek Jain, Prasun Chakrabarti , Massimo Mitolo , Zbigniew Leonowicz, Michal Jasinski , Alexander Vinogradov, , Vadim Bolshev , “A Power-Efficient Multichannel Low-Pass Filter Based on the Cascaded Multiple Accumulate Finite Impulse Response (CMFIR) Structure for Digital Image Processing”, *Circuits, Systems and Signal Processing* , 2022 (<http://doi.org/10.1007/s00034-022-01960-5>).
64. Tanima Bhattacharya, Debashrita Das, Giselle A. Borges e Soares, Prasun Chakrabarti, Zhaoquan Ai, Hitesh Chopra, Alexandru Madalin Hasan , Simona Cavalu , “Novel Green Approaches for the Preparation of Gold Nanoparticles and Their Promising Potential in Oncology”, *Processes* , 10(2) : 426, 2022
65. Imayanmosha Wahlang, Arnab Kumar Maji , Goutam Saha, Prasun Chakrabarti, Michal Jasinski , Zbigniew Leonowicz, Elzbieta Jasinska , “Brain Magnetic Resonance Imaging Classification using Deep Learning Architectures with gender and age” , *Sensors* , 22 :1766, 2022.
66. S. Hemalatha, Pravin R. Kshirsagar, Hariprasath Manoharan, N. Vasantha Gowri, A. Vani, Sana Qaiyum, P. Vijayakumar, Vineet Tirth, Sulaima Lebbe Abdul Haleem, Prasun Chakrabarti and Dawit Mamiru Teressa “Novel Link Establishment Communication Scheme against Selfish Attack Using Node Reward with Trust Level Evaluation Algorithm in MANET” , *Wireless Communications and Mobile Computing* , 2022 <https://www.hindawi.com/journals/wcmc/2022/6776378/>.
67. M Vasaghi , S Z Mousavi, M Owringi, M Zadeh, Ali Kamali, Mehdi Dehghani, Prasun Chakrabarti, Mohammad Nami , “Neural Correlates in Functional Brain Mapping among Breast Cancer Survivors Receiving Different Chemotherapy Regimens; a qEEG/HEG – based Investigation”, *Japanese Journal of Clinical Oncology*, 2022 (<https://doi.org/10.1093/jjco/hyac121>).
68. Maryam Owringi, Mohammad Javad Gholamzadeh, Maryam Vasaghi Gharamaleki, Seyedeh Zahra Mousavi, Ali-Mohammad Kamali, Mehdi Dehghani, Prasun Chakrabarti , Mohammad Nami , “Comparative analysis of the chemotherapy-related cognitive impairments in patients with breast cancer: a community-based research” , *Cancer Investigation*, 2022.
69. Hariprasath Manoharan, Radha Krishna Rambola, Pravin R. Kshirsagar, Prasun Chakrabarti, Jarallah Alqahtani, Quadri Noorulhasan Naveed, Saiful Islam, Walelign Dinku Mekuriyaw, "Aerial Separation and Receiver Arrangements on Identifying Lung Syndromes Using the Artificial Neural Network", *Computational Intelligence and Neuroscience*, 2022.
70. Negin Farhadian , Alireza Moradi , Mohammad Nami , Kamran Kazemi , Mohammad Rasoul Ghadami , Alireza Ahmadi , Reza Mohammadi , Mohammad Naseh Talebi , Prasun Chakrabarti , Babak Kateb , Habibolah Khazaie , “The nexus between sleep disturbances and mental health outcomes in military staff – a systematic review” , *Sleep Science* , 15(3), 2022.
71. Tadiboina, S. N. (2022). The Use Of AI In Advanced Medical Imaging. *Journal of Positive School Psychology*, 6(11), 1939-1946.

72. AbdulKader, H., ElAbd, E., & Ead, W. (2016). Protecting Online Social Networks Profiles by Hiding Sensitive Data Attributes. *Procedia Computer Science*, 82, 20–27.
73. Fattoh, I. E., Kamal Alsheref, F., Ead, W. M., & Youssef, A. M. (2022). Semantic sentiment classification for covid-19 tweets using universal sentence encoder. *Computational Intelligence and Neuroscience*, 2022, 1–8. <https://doi.org/10.1155/2022/6354543>
74. Ead, W. M., Abdel-Wahed, W. F., & Abdul-Kader, H. (2013). Adaptive Fuzzy Classification-Rule Algorithm In Detection Malicious Web Sites From Suspicious URLs. *Int. Arab. J. E Technol.*, 3, 1–9.
75. Abdelazim, M. A., Nasr, M. M., & Ead, W. M. (2020). A survey on classification analysis for cancer genomics: Limitations and novel opportunity in the era of cancer classification and Target Therapies. *Annals of Tropical Medicine and Public Health*, 23(24). <https://doi.org/10.36295/asro.2020.232434>
76. Alsheref, F. K., Fattoh, I. E., & M.Ead, W. (2022). Automated prediction of employee attrition using ensemble model based on machine learning algorithms. *Computational Intelligence and Neuroscience*, 2022, 1–9.
77. Tadiboina, S. N., & Liu, W. (2022). Artificial Intelligence (AI) And Deep Learning (DL) In Medical Diagnosis Process Such As SPECT And PET. *Journal of Positive School Psychology*, 6(8), 10665-10673.
78. J. J. Patil, Y. H. Patil, A. Ghosh, “Comprehensive and analytical review on optical fiber refractive index sensor”, 2020 4th International Conference on Trends in Electronics and Informatics (ICOEI) (48184), IEEE, P. 169-175, June. 15, 2020.
79. H. Bohra, A. Ghosh, “Design and analysis of microstrip low pass and band stop filters”, *International Journal of Recent Technology and Engineering (IJRTE)*, Vol. 8, Issue 3, P. 6944-6951, Sept. 2019.
80. Y. H. Patil, A. Ghosh, “Optical fiber humidity sensors: a review”, 2020 4th International Conference on Trends in Electronics and Informatics (ICOEI) (48184), IEEE, P. 207-213, June. 15, 2020.
81. J. J. Patil, Y. H. Patil, A. Ghosh, “Fiber Optics Refractive Index Sensor based on Intensity Modulation”, 2020 4th International Conference on Electronics, Communication and Aerospace Technology (ICECA), IEEE, P. 623-628, May. 2020.
82. H. Bohra, A. Ghosh, A. Bhaskar, A. Sharma, “A miniaturized notched band microstrip wideband filter with hybrid defected ground structure technique”, 2020 Third International Conference on Smart Systems and Inventive Technology (ICSSIT), IEEE, P. 745-750, Aug. 2020.
83. Y. H. Patil, J. J. Patil, A. Gaikwad, A. Ghosh, “Development of Optical Fiber Test Bench for Intensity-Modulated Optical Fiber Sensors”, 2020 4th International Conference on Trends in Electronics and Informatics (ICOEI) (48184), IEEE, P. 176-180, June. 2020.
84. H. Bohra, A. Ghosh, “A Review on Different Optimization Techniques for Selecting Optimal Parameters in Microstrip Bandpass Filter Design”, *International Journal of Advanced Science and Technology*, Vo. 28, Issue 14, P. 379-394, Nov. 2019.
85. J. Terdale, A. Ghosh, “An intensity-modulated optical fiber sensor with agarose coating for measurement of refractive index”, *International Journal of System Assurance Engineering and Management*, Springer India, P. 1-7, Nov. 2022.
86. J. J. Patil, A. Ghosh, “Intensity Modulation based U shaped Plastic Optical Fiber Refractive Index Sensor” 2022 6th International Conference on Trends in Electronics and Informatics (ICOEI), IEEE, P. 18-24, Apr. 2022.
87. H. Bohra, A. Ghosh, A. Bhaskar, “Design and Analysis of Spurious Harmonics Suppressed Microstrip Ultrawide Band Filter using Modified Defected Ground Structure Techniques”, *Wireless Personal Communications*, Springer US, Vol. 121, Issue 1, P. 361-380, Nov. 2021.

88. H. Bohra, A. Ghosh, A. Bhaskar, A. Sharma, "A Miniaturized Ultra-Wideband Low-Pass Microstrip Filter Design using Modified Defected Ground Structure Techniques", *Invertis University*, Vol. 14, Issue 1, P. 25-30, 2021.
89. H. Patidar, P. Chakrabarti, A. Ghosh, "Parallel Computing Aspects in Improved Edge Cover Based Graph Coloring Algorithm", *Indian Journal of Science and Technology*, Vol. 10, P. 25, Jul. 2017.
90. A. Ghosh, P. Chakrabarti, P. Siano, "Approach towards realizing the Security Threats for Mobile IPv6 and Solution Thereof", *International Journal of Computer Applications, Foundation of Computer Science*, Vol. 90, Issue 10, Jan. 2014.
91. A. Ghosh, P. Chakrabarti, D. Bhatnagar, "Performance Evaluation of Optimized Mobile IP Protocol Vis-à-vis Bit Map Indexing Method", *International Journal of Computer Applications, Foundation of Computer Science*, Vol. 75, Issue: 2, Jan. 2013.
92. Tadiboina, S. N. (2022). The Integration Of Handheld And Smartphone-Connected Technologies Into The Doctor-Patient Relationship-AI. *Journal of Positive School Psychology*, 6(11), 2933-2940.
93. M. Farman, A. Akgül, M.T. Tekin, M. M. Akram, A. Aqeel , E. E. Mahmoud, I. S. Yahia, "Fractal fractional-order derivative for HIV/AIDS model with Mittag-Leffler kernel", *Alex. Eng. J*, vol. 61, no. 12, pp. 10965-10980, April 2022.
94. K.S. Nisar, A. Aqeel, M. Inc, M. Farman, H. Rezazadeh, L. Akinyemi, M.M. Mannan, "Analysis of dengue transmission using fractional order scheme", *Aims Math*, vol. 7 no. 5, pp. 8408–8429, May 2022.
95. M.M. Akram, M. Farman, A. Akgül, M. U. Saleem, A. Ahmad, M. Partohaghigh, F. Jarad, "Analysis of HIV/AIDS model with Mittag-Leffler kernel", *Aims Math*, vol. 7 no. 7, pp. 13383-13401, July 2022.
96. I. Khalifa, H. Abd Al-glil, and M. M. Abbassy, "Mobile hospitalization," *International Journal of Computer Applications*, vol. 80, no. 13, pp. 18–23, 2013.
97. I. Khalifa, H. Abd Al-glil, and M. M. Abbassy, "Mobile hospitalization for Kidney Transplantation," *International Journal of Computer Applications*, vol. 92, no. 6, pp. 25–29, 2014.
98. M. M. Abbassy and A. Abo-Alnadr, "Rule-based emotion AI in Arabic Customer Review," *International Journal of Advanced Computer Science and Applications*, vol. 10, no. 9, 2019.
99. M. M. Abbassy and W. M. Ead, "Intelligent Greenhouse Management System," 2020 6th International Conference on Advanced Computing and Communication Systems (ICACCS), 2020.
100. M. M. Abbassy, "Opinion mining for Arabic customer feedback using machine learning," *Journal of Advanced Research in Dynamical and Control Systems*, vol. 12, no. SP3, pp. 209–217, 2020.
101. M. M. Abbassy, "The human brain signal detection of Health Information System IN EDSAC: A novel cipher text attribute based encryption with EDSAC distributed storage access control," *Journal of Advanced Research in Dynamical and Control Systems*, vol. 12, no. SP7, pp. 858–868, 2020.
102. M. M. and S. Mesbah, "Effective e-government and citizens adoption in Egypt," *International Journal of Computer Applications*, vol. 133, no. 7, pp. 7–13, 2016.
103. M.M.Abbassy, A.A. Mohamed "Mobile Expert System to Detect Liver Disease Kind", *International Journal of Computer Applications*, vol. 14, no. 5, pp. 320–324, 2016.
104. R. A. Sadek, D. M. Abd-alazeem, and M. M. Abbassy, "A new energy-efficient multi-hop routing protocol for heterogeneous wireless sensor networks," *International Journal of Advanced Computer Science and Applications*, vol. 12, no. 11, 2021.
105. S. Derindere Köseoğlu, W. M. Ead, and M. M. Abbassy, "Basics of Financial Data Analytics," *Financial Data Analytics*, pp. 23–57, 2022.
106. W. Ead and M. Abbassy, "Intelligent Systems of Machine Learning Approaches for developing E-

- services portals,” EAI Endorsed Transactions on Energy Web, p. 167292, 2018.
107. W. M. Ead and M. M. Abbassy, “A general cyber hygiene approach for financial analytical environment,” *Financial Data Analytics*, pp. 369–384, 2022.
 108. W. M. Ead and M. M. Abbassy, “IOT based on plant diseases detection and classification,” 2021 7th International Conference on Advanced Computing and Communication Systems, 2021.
 109. W. M. Ead, M. M. Abbassy, and E. El-Abd, “A general framework information loss of utility-based anonymization in Data Publishing,” *Turkish Journal of Computer and Mathematics Education*, vol. 12, no. 5, pp. 1450–1456, 2021.
 110. Hashem Shatnawi, “Computational Fluid Flow Model for the Development of an Arterial Bypass Graft”, *CFD Lett.*, vol. 14, no. 10, pp. 99-111, Oct. 2022. <https://doi.org/10.37934/cfdl.14.10.9911>
 111. A. Ahmad et al., “Energy Efficient Intrusion Detection in a heterogeneous environment of Wireless sensor networks,” *NeuroQuantology*, vol. 20, no. 13, pp. 1493–1503, 2022.
 112. A. R. Yeruva, C. S. L. Vijaya Durga, G. B. K. Pant, P. Chaturvedi and A. P. Srivastava, "A Smart Healthcare Monitoring System Based on Fog Computing Architecture," 2022 2nd International Conference on Technological Advancements in Computational Sciences (ICTACS), 2022, pp. 904-909.
 113. A. R. Yeruva, P. Choudhari, A. Shrivastava, D. Verma, S. Shaw and A. Rana, "Covid-19 Disease Detection using Chest X-Ray Images by Means of CNN," 2022 2nd International Conference on Technological Advancements in Computational Sciences (ICTACS), 2022, pp. 625-631.
 114. A. Rana, A. Reddy, A. Shrivastava, D. Verma, M. S. Ansari and D. Singh, "Secure and Smart Healthcare System using IoT and Deep Learning Models," 2022 2nd International Conference on Technological Advancements in Computational Sciences (ICTACS), 2022, pp. 915-922.
 115. K. Sridhar, Ajay Reddy Yeruva, Renjith P N, Asmita Dixit, Aatif Jamshed, and Ravi Rastogi, “Enhanced Machine learning algorithms Lightweight Ensemble Classification of Normal versus Leukemic Cel”, *Journal of Pharmaceutical Negative Results*, Vol.13, no.SI-9, pp. 496–505, 2022.
 116. Nita S. patil, Sanjay M. Patil, Chandrashekhar M. Raut, Amol P. Pande, Ajay Reddy Yeruva, and Harish Morwani, “An Efficient Approach for Object Detection using Deep Learning”, *Journal of Pharmaceutical Negative Results*, Vol.13, no.SI-9, pp. 563–572, 2022.
 117. P. William, M. Shamim, A. R. Yeruva, D. Gangodkar, S. Vashisht and A. Choudhury, "Deep Learning based Drowsiness Detection and Monitoring using Behavioural Approach," 2022 2nd International Conference on Technological Advancements in Computational Sciences (ICTACS), 2022, pp. 592-599.
 118. T. Vinoth Kumar, A. R. Yeruva, S. Kumar, D. Gangodkar, A. L N Rao and P. Chaturvedi, "A New Vehicle Tracking System with R-CNN and Random Forest Classifier for Disaster Management Platform to Improve Performance," 2022 2nd International Conference on Technological Advancements in Computational Sciences (ICTACS), 2022, pp. 797-804.
 119. B. R. Rajagopal, B. Anjanadevi, M. Tahreem, S. Kumar and M. Debnath, and K. Tongkachok, "Comparative Analysis of Blockchain Technology and Artificial Intelligence and its impact on Open Issues of Automation in Workplace," 2022 2nd International Conference on Advance Computing and Innovative Technologies in Engineering (ICACITE), 2022, pp. 288-292.
 120. B.R. Rajagopal, E. Kannapiran, A.D. Gupta, M.Momin and D.S.K. Chakravarthy, "The future prospects and challenges of implementing big data in healthcare management using Structural equation model analysis," *Bull. Env. Pharmacol. Life Sci.*, Spl Issue [1] 2022, pp. 1111-1119, 2022.
 121. N.P. Krishnam, M.S. Ashraf, B.R. Rajagopal, P. Vats and D.S.K. Chakravarthy and S.M. Rafi, "Analysis Of Current Trends, Advances And Challenges Of Machine Learning (ML) And Knowledge Extraction: From ML To Explainable AI," *Industry Qualifications The Institute of Administrative Management UK*, Vol.58, pp. 54-62, May 2022.

122. A.D.Gupta, S.M. Rafi, B.R. Rajagopal, T.Milton and S.G.Hymlin, "Comparative analysis of internet of things (IoT) in supporting the health care professionals towards smart health research using correlation analysis," *Bull.Env.Pharmacol. Life Sci.*, Spl Issue [1] 2022, pp. 701-708, 2022.
123. Roja Boina, "Assessing the Increasing Rate of Parkinson's Disease in the US and its Prevention Techniques", *International Journal of Biotechnology Research and Development*, 3(1), pp. 1-18, 2022.
124. K. Suresh and E. Parimalasundar, "A Modified Multi Level Inverter with Inverted SPWM Control," in *IEEE Canadian Journal of Electrical and Computer Engineering*, vol. 45, no. 2, pp. 99-104, Spring 2022.
125. K. Suresh and E. Parimalasundar, "A novel dual-leg DC-DC converter for wide range DC-AC conversion," *Automatika*, vol. 63, no. 3, pp.572-579, 2022.
126. Parimalasundar Ezhilvannan and Suresh Krishnan, "An efficient asymmetric direct current (DC) source configured switched capacitor multi-level inverter," *Journal Européen des Systèmes Automatisés*, vol. 53, no. 6, pp.853-859, 2020.
127. E. Parimalasundar, S. Jayakumar, R. Ravikumar and K. Suresh, "Investigation analysis of open circuit and short circuit fault on cascaded H-bridged multilevel inverter using artificial neural network approach," *International Journal of Electrical and Electronics Research (IJEER)*, vol. 10, no. 2, pp.320-326.
128. R. Senthilkumar, B. G. Geetha, "Asymmetric Key Blum-Goldwasser Cryptography for Cloud Services Communication Security," *Journal of Internet Technology*, vol. 21, no. 4 , pp. 929-939, Jul.2020.
129. Priscila, S. S., Rajest, S. S., T, S. and G, G. (2022) "An Improvised Virtual Queue Algorithm to Manipulate the Congestion in High-Speed Network", *Central Asian Journal of Medical and Natural Science*, 3(6), pp. 343-360.
130. Rajest, S. S., Regin, R., T, S. and R, S. (2022) "Strategic Leadership And Alignment Affect Organisation Performance", *Central Asian Journal Of Mathematical Theory And Computer Sciences*, 3(12), pp. 248-266. doi: 10.17605/OSF.IO/9AB42.
131. R, S., Rajest, S. S., T, S., & Regin, R. (2023). The Effects of Effective Management of Human Resources on The Overall Performance of An Organization. *Central Asian Journal of Mathematical Theory and Computer Sciences*, 4(1), 1-20.
132. Regin, R., Rajest, S. S., T, S., & R, S. (2023). Human Resource Perspective and Pitfalls at Work. *Central Asian Journal of Innovations on Tourism Management and Finance*, 4(1), 31-49.
133. T, S., Rajest, S. S., Regin, R., & R, S. (2023). Effect Of Working Environmental Employee Satisfaction On Organizational Performance. *Central Asian Journal Of Mathematical Theory And Computer Sciences*, 4(1), 29-48.
134. Senthil kumar, R., Geetha, B.G. Signature Verification and Bloom Hashing Technique for Efficient Cloud Data Storage. *Wireless Pers Commun* 103, 3079–3097,2018.
135. R. Agarwal and N. Rao, "ML-based classifier for Sloan Digital Sky spectral objects," *Neuroquantology*, vol. 20, no. 6, pp. 8329–8358, 2022, doi: 10.14704/nq.2022.20.6.NQ22824.
136. R. Agarwal, "Edge Detection in Images Using Modified Bit-Planes Sobel Operator," 2014, pp. 203–210.
137. A. Rashi and R. Madamala, "Minimum relevant features to obtain ai explainable system for predicting breast cancer in WDBC," *Int J Health Sci (Qassim)*, Sep. 2022, doi: 10.53730/ijhs.v6nS9.12538.
138. R. A. A. Agarwal, "Decision Support System designed to detect yellow mosaic in Pigeon pea using Computer Vision," *Design Engineering (Toronto)*, vol. 8, pp. 832–844, 2021.
139. R. Agarwal, S. Hariharan, M. Nagabhushana Rao, and A. Agarwal, "Weed Identification using K-Means Clustering with Color Spaces Features in Multi-Spectral Images Taken by UAV," in 2021 IEEE International Geoscience and Remote Sensing Symposium IGARSS, Jul. 2021, pp. 7047–7050. doi:

- 10.1109/IGARSS47720.2021.9554097.
140. D.K. Srivastava and B. Roychoudhury, "Words are important: A textual content based identity resolution scheme across multiple online social networks," *Knowledge-Based Systems*, vol. 195, 105624, 2020.
 141. D.K. Srivastava and B. Roychoudhury, "Understanding the Factors that Influence Adoption of Privacy Protection Features in Online Social Networks," *Journal of Global Information Technology Management*, vol.24, no.3, pp. 164-182, August 2021
 142. S. R. Vadyala, S. N. Betgeri, J. C. Matthews, and E. Matthews, "A review of physics-based machine learning in civil engineering." *Results in Engineering*, vol. 13, p. 100316, 2022.
 143. S. R. Vadyala, S. N. Betgeri, and N. P. Betgeri, "Physics-informed neural network method for solving one-dimensional advection equation using PyTorch." *Array*, vol. 13, p. 100110, 2022, doi: 10.1016/j.array.2021.100110.
 144. S. R. Vadyala and E. A. Sherer, "Natural Language Processing Accurately Categorizes Indications, Findings and Pathology Reports From Multicenter Colonoscopy (Preprint)." 2021, doi: 10.2196/preprints.32973.
 145. S. R. Vadyala, S. N. Betgeri, E. A. Sherer, and A. Amritphale, "Prediction of the number of COVID-19 confirmed cases based on K-means-LSTM." *Array*, vol. 11, p. 100085, 2021, doi: 10.1016/j.array.2021.100085.
 146. S. Pandya, T. R. Gadekallu, P. K. Reddy, W. Wang and M. Alazab, "InfusedHeart: A Novel Knowledge-Infused Learning Framework for Diagnosis of Cardiovascular Events," in *IEEE Transactions on Computational Social Systems*, doi: 10.1109/TCSS.2022.3151643.
 147. Parvathi K, Santhi T, Makeswari M, Nirmaladevi V, Rathinam R. Ricinus Communis Activated Charcoal Preparation, Characterization and Application for Methyl Red Adsorptive Removal. *Orient J Chem* 2022;38(1), Pg. 110-117.
 148. Rathinam R, Brindha T, Petchiammal M, Mohamed Ibrahim A, Photo-Electrocatalytic Degradation Of Aqueous Rhodamine B Dye Using Titanium Electrodes Coated With RuO₂/IrO₂/TaO₂, *Indian Journal of Environmental protection*, 41(12), pp.1365-1371, 2021.
 149. Umadevi M, Rathinam R, Brindha T, Dheenadhayalan S, Pattabhi S, Application of Electro- Chemical Oxidation for the Treatment of Reactive Red 195 using Graphite Electrode, *Asian Journal of Biological and Life Sciences*, 2022,10 (3), 620-625.
 150. Brindha T, Rathinam R, Dheenadhayalan S, Sivakumar R. Nanocomposite Coatings in Corrosion Protection Applications: An Overview. *Orient J Chem* 2021;37(5), Pg.1062-1067.
 151. Parvathi K, Santhi T, Makeswari M, Nirmaladevi V, Rathinam R (2022) Ricinus Communis Activated Charcoal Preparation, Characterization and Application for Methyl Red Adsorptive Removal. *Orient Journal of Chemistry*, 38(1), 110-117.
 152. Rathinam R, Brindha T, Petchiammal M, Mohamed Ibrahim A (2021) Photo-Electrocatalytic Degradation Of Aqueous Rhodamine B Dye Using Titanium Electrodes Coated With RuO₂/IrO₂/TaO₂, *Indian Journal of Environmental protection*, 41(12), 1365-1371,
 153. Umadevi M, Rathinam R, Brindha T, Dheenadhayalan S, Pattabhi S (2022) Application of Electro- Chemical Oxidation for the Treatment of Reactive Red 195 using Graphite Electrode, *Asian Journal of Biological and Life Sciences*, 10(3), 620-625.
 154. Brindha T, Rathinam R, Dheenadhayalan S, Sivakumar R (2021). Nanocomposite Coatings in Corrosion Protection Applications: An Overview. *Orient J Chem.*, 37(5), 1062-1067.
 155. Ismail R M A, Rathinam R, Al-Jamal M, Ramachandran S K, Al-Mattarneh H, Pant B, Patil P Y (2022) Mn-BIM Based Photo-Catalytic Degradation of Hazardous Industrial Organic Pollutants in Fresh Water.

Advances in Science and Technology. 117, 53-58

156. Rathinam, R, Singh D P, Dutta A., Rudresha S, Ali S R, Chatterjee P (2022) TiO₂ Nanoparticles Based Peroxidase Mimics for Colorimetric Sensing of Cholesterol and Hydrogen Peroxide. Advances in Science and Technology, 117, 85-90.
157. Singh A, Rathinam R, Yadav A K, Vasudevan R, Kulandhaisamy I, Purushotham M, Patil P Y. (2022) A Simple Approach of CQDs@MoS₂ Nanosheets for Turn-On Fluorescence Sensor for Detection of Pb²⁺ Ions. Key Engineering Materials, 928, 33-38.
158. Karthick L, Rathinam R, Abdul Kalam Sd., Ganesh Babu Loganathan, Sabeenian R S, Joshi S K, Ramesh L, Mohammed Ali H, Wubishet Degife Mammo (2022) Influence of Nano-/Microfiller Addition on Mechanical and Morphological Performance of Kenaf/Glass Fibre-Reinforced Hybrid Composites. Journal of Nanomaterials, Article ID 9778224, 10 pages ,
159. Govindaraj M, Babu S., Rathinam R. Vasini V, Vijayakumar K (2022) Integrated electrocoagulation–photoelectrocatalytic oxidation for effective treatments of aqueous solution bisphenol-A using green-synthesized ZnO nanoparticles. Chem. Pap.

